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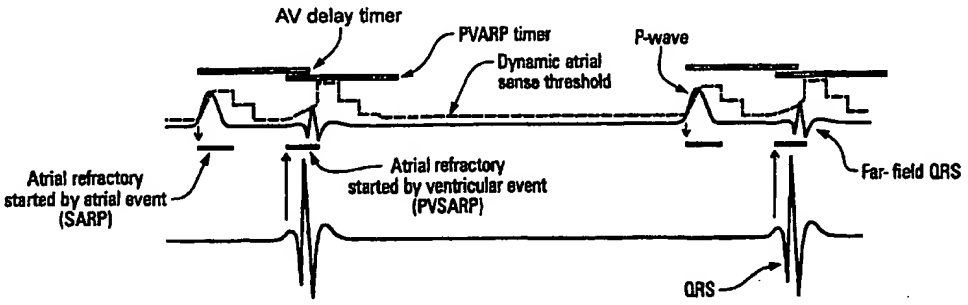
(54) Title: AVOIDING FAR-FIELD QRS IN A TACHY DETECTIONS DEVICE



(57) Abstract

Method for avoiding the detection of a far–field QRS by the atrial detector of a heart pacemaker or ICD while allowing the detection of true atrial signal to maximum possible extent; the method comprising generating a Short Atrial Refractory Period (SARP) following an atrial sensed or paced event by means of a SARP timer, blanking of the atrial detector following a ventricular paced event, generating a Post Ventricular Short Atrial Refractory Period (PVSARP) following a ventricular sensed or paced event by means of a PVSARP timer, generating a temporary decrease in the sensivity of amplifier for the atrial signal for a time period following the elapse of the mentioned PVSARP, gradually increasing the sensivity of the amplifier for the atrial signal after said time period.

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Avoiding Far-Field QRS in a Tachy Detections Device

1. Prior Art

In a dual-chamber cardiac pulse generator, it is desirable not to detect a far-field QRS Signal [by the atrial detector] and mistake it for being a P-wave. In a bradycardia pacemaker where detection of high atrial rate is not necessary this is avoided by keeping the atrial detector refractory during periods where far-field QRS or other unwanted signals might be present. One example of such [extended] atrial refractory period is the so called "Total Atrial Refractory Period" (TARP) which starts at an atrial event and, by having appropriate value, remains in effect until reasonable amount of time after the following ventricular event. Another example is keeping the atrial detector refractory until the following ventricular event and then, starting a "Post Ventricular Atrial Refractory Period" (PVARP) having a reasonable duration. However, in devices where detection of high atrial rate is necessary, examples being ICDs and also pacemakers implementing mode switching as a result of high atrial rate, the mentioned TARP and PVARP may result in

undersensing of the true atrial signal thereby compromising the response from the device. It can be mentioned here that the purpose of the PVARP (or the portion of the TARP that remains after a ventricular sensed or paced event) is to prevent initiation of the so called Pacemaker Mediated Tachycardia (PMT) by avoiding sensing of the retrograde conduction by the atrial detector [which in an atrial tracking mode would lead to triggering of a ventricular pacing pulse].

2. Summary of the Invention

A scheme aimed at detecting maximum possible amount of true atrial signal while avoiding far-field QRS and other unwanted signal is disclosed. The innovation lies in the avoidance of the far-field QRS. Other unwanted signals, e.g. other parts than the P-wave of the atrial signal, can be handled by appropriate atrial refractory period which need not be very long, thus, allowing detection of high [true] atrial rate.

Thereby a mechanism is implemented, so that the shortest possible Short Atrial Refractory Period (SARP) and Post Ventricular Short Atrial Refractory Period (PVSARP) can be used, thus enabling detection of high rate atrial rhythms.

3. Description of the Invention

The invention allows use of short atrial refractory periods when attempting to detect high atrial rate (if prevailing]. Use of "Short Atrial Refractory Period" (SARP) following an atrial sensed or paced event is suggested - as short as possible but long enough to avoid multiple sensing and detection of unwanted artifacts of the atrial signal (see figure 1).

Please refer to figure 1 for the following description. The present invention suggests use of a "Post Ventricular Short Atrial Refractory Period" (PVSARP) following a ventricular sensed event. Following the elapse of the mentioned PVSARP, the

invention further suggests a temporary decrease in the sensitivity of the atrial detector and which is increased gradually to its normal value The temporary decrease in the sensitivity helps in keeping the PVSARP very short, thus, leading to detection of true atrial signal to the maximum possible extent. The value of PVSARP must be determined individually for each patient by monitoring the signal and the response of the atrial detector - one value could be zero.

A_further improvement is suggested by determining the amount of temporary decrease in the atrial sensitivity as a function of its current value [i.e. one that is in effect before enforcing the decrease]. Yet another improvement is suggested by letting the dynamic sensitivity threshold reach the peak of input signal — as seen during the PVSARP - towards the end of the PVSARP; and then determining the amount of the temporary decrease as a function of this value. The PVSARP and the temporary decrease in the atrial sensitivity are aimed at avoiding sensing the far-field QRS signal by the atrial detector.

While the use of SARP and PVSARP — both having short values — help in detecting high atrial rate, for the traditional bradycardia support function in the same device, the invention further suggests incorporation of AV delay timer and PVARP timer as shown in figure 1. While these timers are running, the atrial detector must be kept logically refractory as far as the bradycardia support is concerned — what this means is that the bradycardia timings etc. must not be affected by any atrial detections which may occur while any of these two timers is running. Please note that atrial detections are possible only in the zone shown in grey since the atrial detector is refractory due to SARP or PVASRAP initially (the zone shown in clear). Also note that the figure illustrates a running AV delay timer determinated by a ventricular sensed event. In devices based on the use of TARP, a TARP timer can be implemented instead of AV delay and PVARP timers.

Following a ventricular paced event, the atrial detector is blanked for some time to avoid detection of the ventricular pacing pulse or its after-potential by the atrial

detector [and also to avoid saturation of die atrial detector]. The disclosed scheme can be used - together with this traditional blanking of the atrial detector — also following a ventricular paced event.

In rare cases, a QRS may be "seen" by die atrial detector before it is sensed by the ventricular detector - the top trace in figure 2 is the input signal to the atrial detector. The invention advocates a delayed signal processing by the atrial detector to manage such cases — the middle trace (shown using dotted line) in figure 2 is the delayed signal. It has been found that this delay need not be very long (16 ms is usually enough). This delay will, automatically, discard the "seen" early QRS as soon as the QRS is sensed by the ventricular detector resulting in the start of the PVSARP.

Claims

1. A method for avoiding the detection of a far-field QRS by the atrial detector of a heart pacemaker or ICD while allowing the detection of true atrial signal to maximum possible extent; the method being characterized by

generating a Short Atrial Refractory Period (SARP) following an atrial sensed or paced event by means of a SARP timer,

blanking of the atrial detector following a ventricular paced event,

generating a Post Ventricular Short Atrial Refractory Period (PVSARP) following a ventricular sensed or paced event by means of a PVSARP timer,

generating a temporary decrease in the sensivity of amplifier for the atrial signal for a time period following the elapse of the mentioned PVSARP,

gradually increasing the sensivity of the amplifier for the atrial signal after said time period.

2. Method as described in Claim 1 where for a bradycardia support function, an AV-delay timer is started following an atrial sensed or paced event or following the elapse of the SARP and a PVARP (Post Ventricular Atria1 Refractory Period) timer is started following a ventricular sensed or paced event following the elapse of the PVSARP; the bradycardia support remains unaffected by atrial detections which occur while any of these two timers is running.

3. Method as described in Claim 1 where for bradycardia support function, a TARP (Total Atrial Refractory Period) timer is started following an atrial

sensed or paced event or following the elapse of the SARP; the bradycardia support remaining unaffected by atrial detections which occur while this timer is running.

4. Method as described in Claim 1 or 2 or 3, where the duration of PVSARP is selected to be zero.

5. Method as in Claim 1 or 2 or 3 or 4 where the amount of the temporary decrease in the atrial sensivity is a function of its current dynamic value.

6. Method as in Claim 5 where die atrial sensitivity threshold is set to the peak of the input signal — as found during die PVSARP — towards the end of die PVSARP; and then the amount of die temporary decrease is based on this value.

7. Method as in Claim 1 or 2 or 3 or 4 where the temporary decrease in the atrial sensivity is made to a fixed sensivity value.

8. Method as in Claim 1 or 2 or 3 or 4 or 5 or 6 or 7 with the addition of delayed processing of the signal by the atrial detector to avoid the detection of a far-field QRS, which precedes the detection by the ventricular detector; the start of a PVSARP automatically discards the signal which may be in the pipeline (formed by a register or memory or delay line) waiting to be processed.

9. Dual-chamber cardiac pace generator or ICD including functional blocks designed to individually perform the method steps as claimed above.

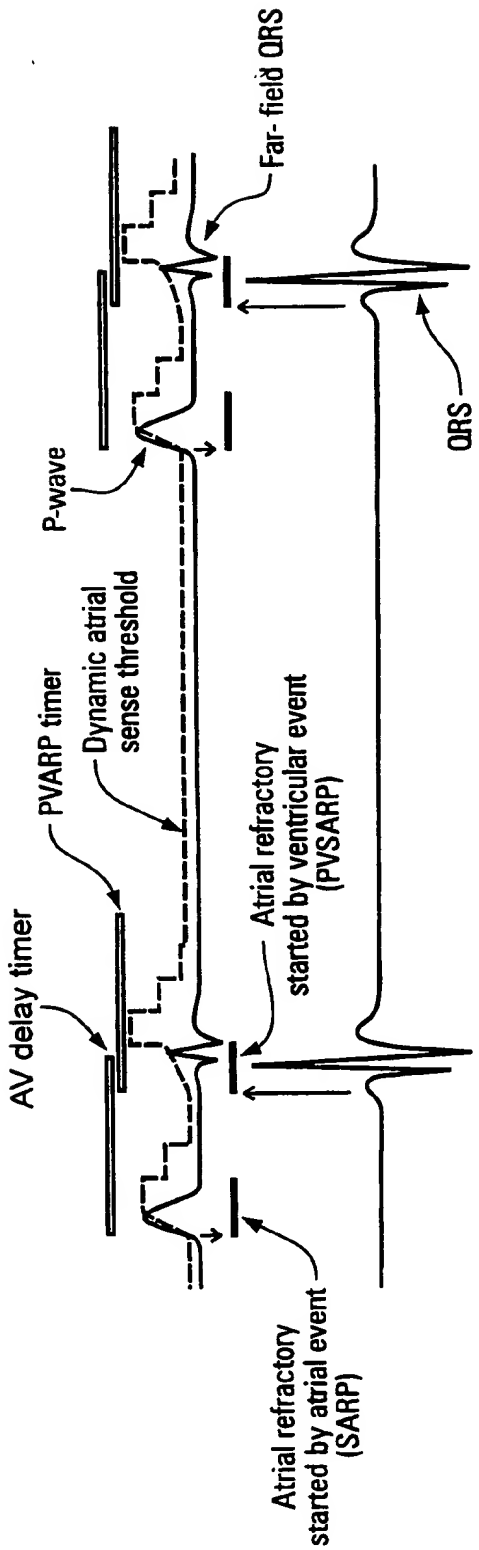
Far- field QRS
QRS
P-wave
Dynamic atrial sense threshold
PVARP timer
AV delay timer
Atrial refractory started by ventricular event (PVSARP)
Atrial refractory started by atrial event (SARP)

Fig.1

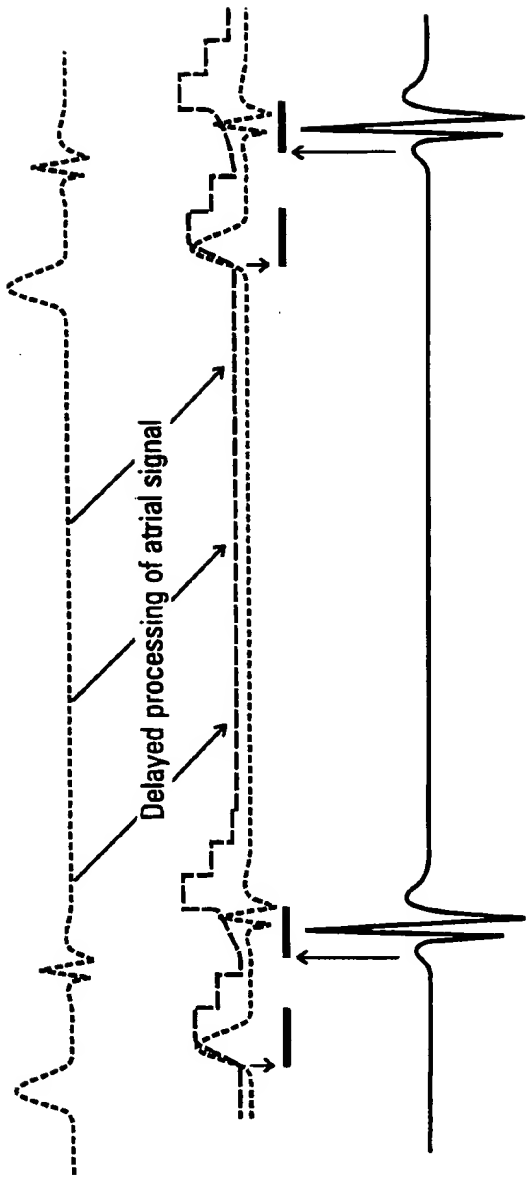

Fig.2

INTERNATIONAL SEARCH REPORT

Inter ɔnal Application No
PCT/EP 00/03174

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61N1/368

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 705 620 A (VITATRON MEDICAL BV) 10 April 1996 (1996-04-10) column 5, line 6 -column 7, line 4	1,9
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A	US 5 759 196 A (HESS MICHAEL F ET AL) 2 June 1998 (1998-06-02) column 6, line 62 -column 9, line 14	1,9
A	US 5 755 739 A (PANKEN ERIC J ET AL) 26 May 1998 (1998-05-26) column 6, line 66 -column 7, line 47 column 10, line 15-21	1,9

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☒ Patent family members are listed in annex.

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